



GeoSHED Software for Wetlands Drainage Analysis

PURPOSE: This technical note documents recent software developments in automated drainage basin analysis and describes how the tools can be used in wetland environments.

BACKGROUND: A detailed knowledge of wetland hydrology is perhaps the first, if not the most important, aspect of wetland behavior that the wetland scientist must understand prior to implementing wetland improvements or designing new wetlands. Hydrologic inputs define the frequency and depth of inundation of the wetland which in turn defines habitability for various plants and wildlife. In fact, wetlands are defined and typed by the frequency in which they are inundated. Since there are a wide range of wetland types ranging from alpine meadows to tidal marshes, there is a need for generalized tools for studying hydrologic behavior. The tools must be able to quantify runoff from rainfall, route the flow through stream networks within the wetland, and account for groundwater sources and losses. Unfortunately, the requirements for studying each process require different technical approaches and models.

In the early stages of the WRP, tools are being developed that address each aspect of the hydrologic cycle separately with an interest in improving existing tools and making them easy to apply to wetland applications. Three categories are being addressed as distinct entities. They include runoff calculations using such models as HEC-1, calculations of shallow water flow using two-dimensional models such as the TABS system, and groundwater models to determine the effect of groundwater on the wetland water budget. This technical note addresses the first category but ensuing technical notes will address the latter two. Each of the categories will be addressed with consistent data structures to allow them to be coupled when they are mature and when integrated solutions are required.

EXISTING TOOLS: A wide variety of free surface and groundwater tools are available for meaningful hydrologic analyses. The Corps of Engineers and other federal agencies have many computer codes that can determine surface runoff from rainfall information with some degree of confidence. Perhaps the most widely used code is HEC-1 which was written by the Hydrologic Engineering Center (HEC) in Davis, California. This model is well-supported by HEC and there is good documentation including a user's manual (HEC, 1990).

Unfortunately, HEC-1 is time-consuming to use by other than professional hydrologists. Typically, the most time-consuming tasks in setting up a hydrologic simulation involve discretizing the watershed, defining the major streams and sub-basins, calculating drainage areas and other pertinent hydrologic statistics, and writing out this information in a form expected by the hydrologic models. Automated software would minimize the time and number of errors caused by manual watershed analyses. This would result in widespread use of good hydrologic models with greater detail and accuracy given to each hydrologic application.

AUTOMATED INTERFACE: A graphically-based hydrologic pre-processor program (GeoSHED), that was originally developed for generic surface water applications (Jones, et al, 1990), is currently being used to automate each of the tasks discussed above in wetland applications. GeoSHED employs Triangulated Irregular Networks (TINs) to define the topography and calculate vital hydrologic

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statistics. A TIN is a set of data points that are connected by irregular triangles that together describe an irregular surface (Figure 1). TIN's are created by inputting digitized data, either from digital topographic maps or from manually digitized data, and triangulating the points. Once the TIN is created, a continuous surface is modeled by interpolating between the corners of the triangles.

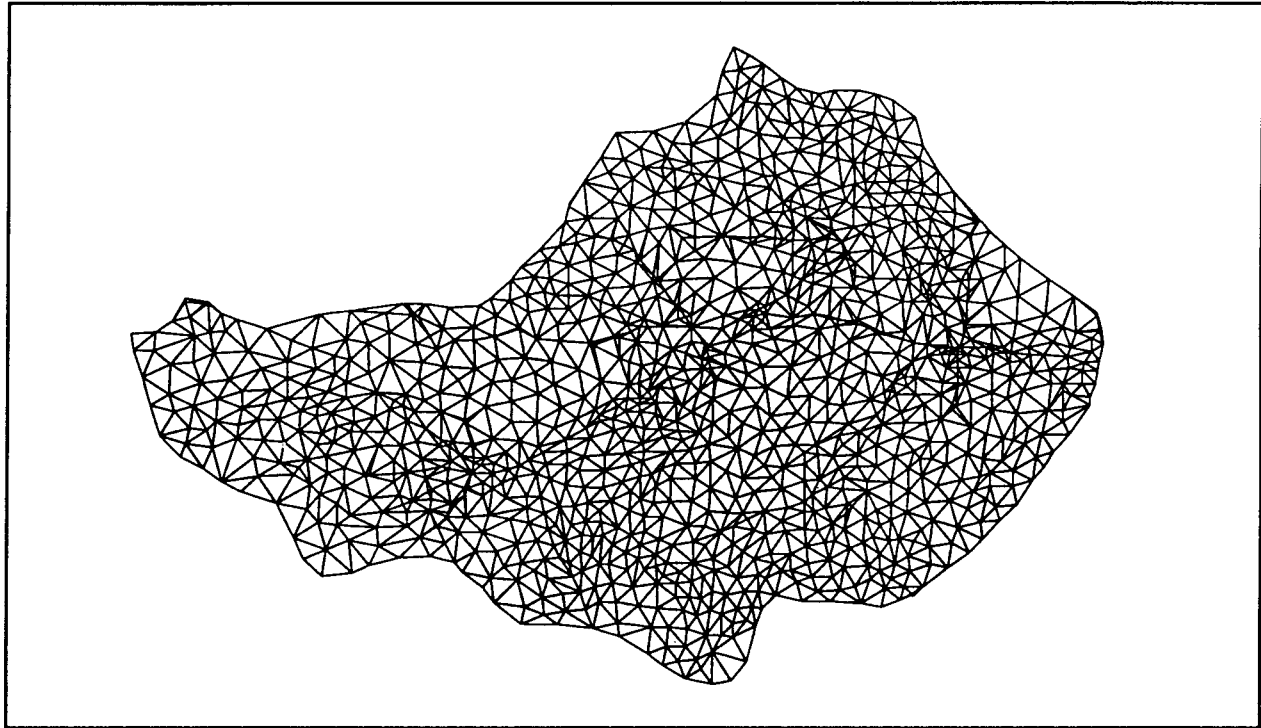


Figure 1. Triangulated Irregular Network (TIN) of a watershed

After the surface is modeled, GeoSHED automatically defines the dominant streams and flow paths on the screen (Figures 2 and 3). In Figure 3, flow path lines are drawn on the screen from the centroid of each triangle down slope in the direction of steepest descent. With the primary streams and flow paths defined, GeoSHED calculates the contributing drainage area to each of the user-defined stream junctions. The drainage areas for each sub-basin along with critical hydrologic statistics for each sub-basin can be displayed (Figure 4). Previously, it was necessary to planimeter each sub-basin manually and type the data into an input file. GeoSHED automatically writes out the data in a form that HEC-1 accepts.

The developed software eliminates most of the tedious tasks in assembling data input files for hydrologic simulations. To run hydrologic simulations of watersheds, all that is needed is a digitized data set with x-, y-, and z-coordinates, the GeoSHED software, and a copy of HEC-1. HEC-1 is available from the Hydrologic Engineering Center and GeoSHED is available from the U.S. Army Engineer Waterways Experiment Station.

COMPUTER INFORMATION: The GeoSHED software runs on most UNIX workstations using X-Windows graphics. It also runs on DOS-based personal computers using WINDOWS 3.1. A user's manual and installation guide are available.

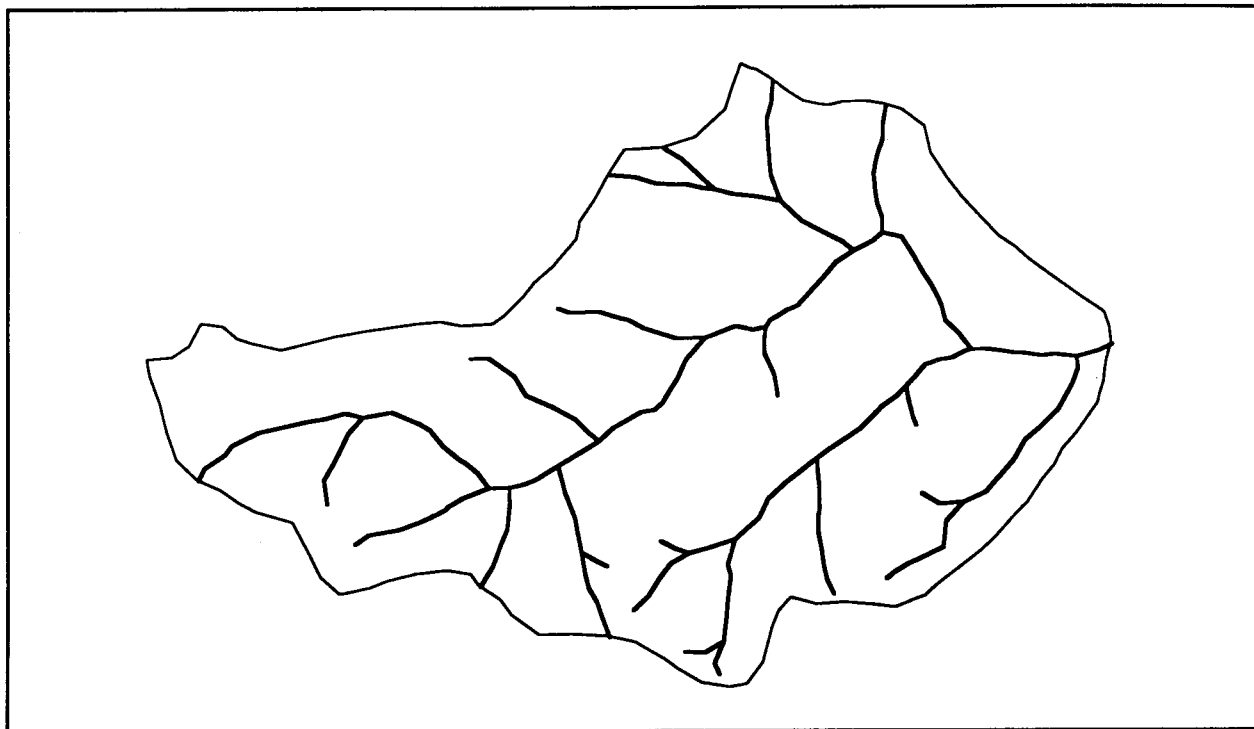


Figure 2. Primary streams defined from the TIN

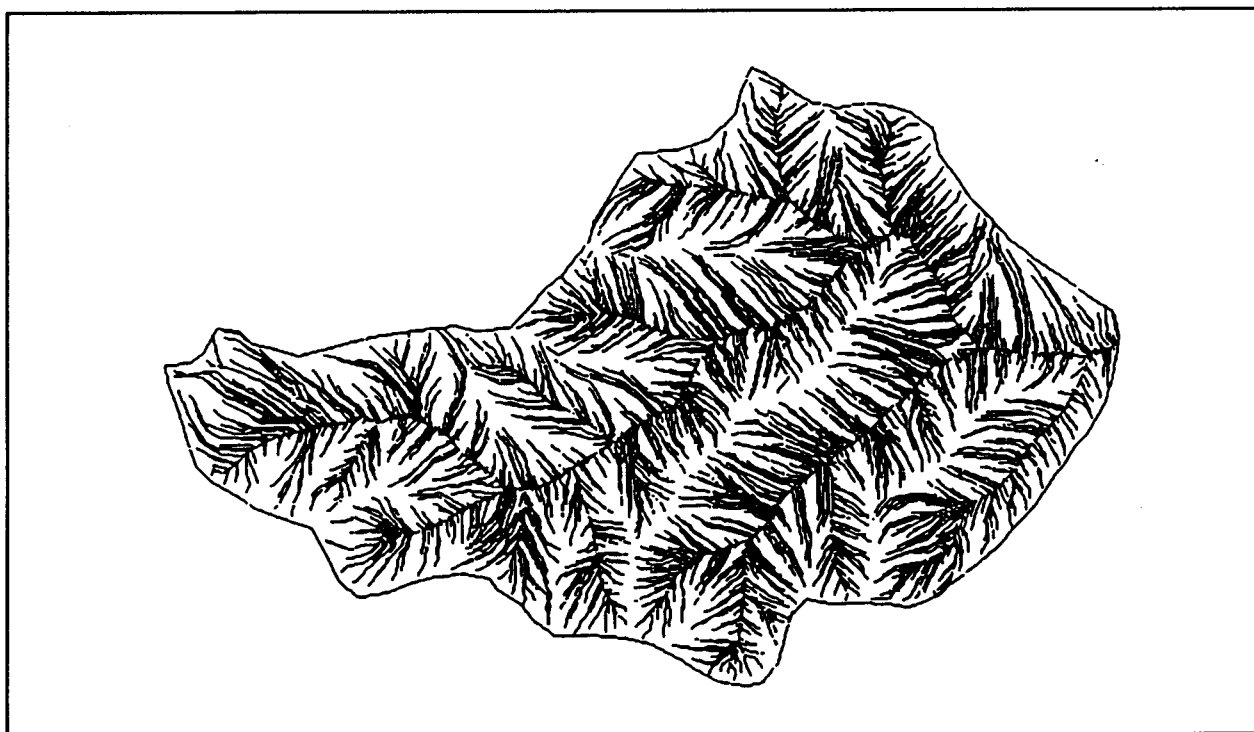


Figure 3. Overland Flow Paths defined by the TIN

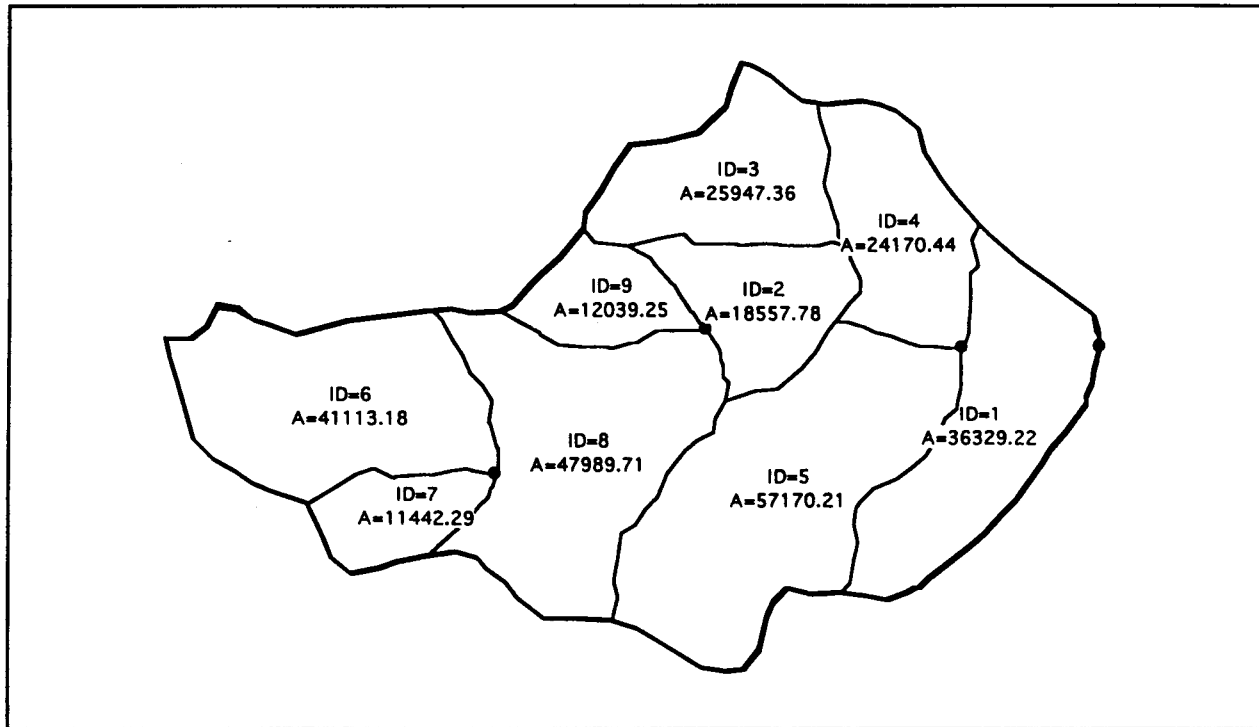


Figure 4. Drainage Areas delineated for each sub-basin using the TIN

The GeoSHED software was written by the Engineering Computer Graphics Laboratory of Brigham Young University in Provo, Utah, in cooperation with the Hydraulics Laboratory at WES and is copyright to Brigham Young University. A limited government license allows Corps office use of software supplied through WES. Other than Corps users may obtain the software from Brigham Young University, (801) 378-5713.

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- Hydrologic Engineering Center. 1990. "HEC-1, Flood Hydrograph Package, User's Manual," U.S. Army Corps of Engineers, Davis, California.
- Jones, Norman L., Stephen G. Wright, and David R. Maidment. 1990. "Watershed Delineation with Triangle Based Terrain Models," ASCE Journal of Hydraulic Engineering, Vol. 116, No. 10, Oct. 1990, pp 1232-1251.

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